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(19) (CA) **CANADIAN PATENT** (12)

(54) Electronic Air Filter

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ABSTRACT

This invention relates to an electronic air filter of the charged media type in which the filter media and screens form a disposable cartridge. The high voltage power supply, which is made long and slender, attaches to the side of the cartridge and it is powered by a low voltage power supply.

This invention relates to an electronic air filter of the charged media type in which the screens and media form a disposable cartridge. This feature makes restoration of a saturated filter easy and sanitary.

Presently available electronic air filters are cleaned by either washing collector plates which accumulate the dust (precipitator type filters), or opening the filter and removing and replacing individual pads (charged media type filters). In cleaning these filters, some of the collected dust falls off the pads, becomes airborne and thus causes pollution.

10 It is the object of my invention to provide an electronic air filter in which the dust collecting media is in the form of a disposable cartridge.

This invention therefore consists of an electronic cartridge air filter comprising an outside frame, two outside conducting screens attached to either side of the frame, an inside conducting screen located inside the outside frame and between the outside conducting screens, fibrous material located between the outside screens and the inside screen, and the cartridge filter being made to accept an attachable power supply for the purpose of providing high voltage to the inside screen with respect to the outside screens, such that if the power supply is attached to the filter the combination of the two forms a complete electronic filter unit which can be loosely inserted into an
20 air handling unit.

A second aspect of the invention consists of a high voltage power supply unit comprising electrode and mechanical attachments so as to be capable of being mechanically attached and electrically connected to a cartridge type electronic air filter, the power supply being powered by a second low voltage power supply via a low voltage cable so that if the high voltage power supply and the cartridge filter are attached together, the combination of the two forms a complete filter unit which can be loosely inserted into an air handling system.

30 The installation of such a filter is easy and safe as two power supplies are provided, one being a low voltage power supply which plugs into the power supply and the other being a high voltage power supply which is powered by the low voltage power supply via a low voltage detachable cord. The high voltage power supply attaches to the cartridge.

The electronic air filter which, although it utilizes several thousand volts for its operation, is made safe by preferably providing an interlock



switch which removes the high voltage from the high voltage power supply.

The filter can also be connected in tandem with other similar filters and be powered by a single high voltage power supply. These and other features of the invention will become evident from the drawings and description provided.

Fig. 1 shows the cartridge type filter of this invention with a high voltage supply attached to the cartridge and a low voltage power supply connected to the high voltage supply by a detachable cord.

Fig. 2 is a cross-sectional view of the cartridge of Fig. 1 showing the two outside screens and the single inside screen.

10 Fig. 3 shows an exploded view of the filter, the high voltage power supply having a high voltage probe and the lower voltage supply being connected to it.

Figs. 4A and 4B are partial cross-sectional views showing the action of a shorting switch when the high voltage probe is inserted in an aperture on the cartridge.

Fig. 5 shows an alternate arrangement wherein the high voltage power supply is provided with screens.

Fig. 6 is an outside view of the alternate type cartridge filter of Fig. 5.

Fig. 7 is a cross-sectional view of the cartridge shown in Fig. 6.

Fig. 8 is a view of two filters connected in tandem showing the high voltage probes and a single high voltage power supply.

Fig. 9 shows the elongated design of the high voltage power supply.

Referring to the drawings, in Fig. 1 and Fig. 2, 1 is an outside rectangular frame made of a material such as an electrically conducting cardboard, plastic or metal. 2 and 3 are electrically conducting outside screens which are held together by frame 1. Screens 2 and 3 are electrically connected together. Screens 2 and 3 are also electrically connected to retainer clips 6 and 7 via frame 1. 4 is an inside conducting screen which is held in position between screens 2 and 3 by fibrous material 5. Fibrous material 5 is made of a dielectric material such as plastic or glass which is easily polarizable by an electrostatic field. 8 is a long and slender metal box containing the high voltage supply electronics (see also Fig. 3). 11 is a low voltage power supply which can be plugged into a household electrical socket by prongs 12. 9 is a cord (two conductor cable) which is plugged into high voltage power supply 8 by connector 10 (plug and socket). High voltage power supply 8 is provided with high voltage probe 13 (see Fig. 4A and 4B). Probe 13 consists of a conductor 14 and an insulating sleeve 15 covering the conductor so that only a small part of the tip is exposed. The cartridge filter is provided with an opening 16 an outside frame 1 where probe 13 can be inserted to provide high voltage for the filter. 17 is a flat metal spring element which is affixed by insulator 18 to the inside of frame 1. Also spring 17 is connected to inside screen 4 by wire 19. Spring element 17 is arranged so that when probe 13 is inserted in opening 16, spring 17 makes contact with the tip of probe 13 and at the same time spring 17 is lifted off frame 1 by probe 13 and it breaks electrical contact with frame 1. This occurs when the high voltage power supply is attached to the cartridge and held in place by clips 6 and 7.

Operation of the filter is as follows:

High voltage power supply 8 is attached to the cartridge filter by retainer clips 6 and 7. Low voltage power supply 11 is plugged into an electrical outlet and cord 9 is plugged into high voltage power supply 8 via connector 10. Thus low voltage (6-28 volts) is supplied to the high voltage power supply. High voltage (4-10KV) from the high voltage power supply is provided to inside screen 4 via probe 13, spring element 17 and wire 19. The high voltage applied to inside screen 4 sets up an electrostatic field between inside screen 4 and outside screens 2 and 3. (Note that the outside screens
10 are connected to the ground side of the high voltage power supply via frame 1 and retainer clips 6 and 7). The electrostatic field polarizes the fibers of fibrous material 5 which is located between the screens. The polarized fibers, which exhibit positive and negative charges on their surfaces, attract any dust particles which pass through the filter by electrostatic attraction. In this way the efficiency of the filter is enhanced.

To replace the cartridge after it has been saturated with dust, low voltage power supply is disconnected from the high voltage power supply by disconnecting connector 10. Then the high voltage power supply 8 is detached from the cartridge by spreading retainer clips 6 and 7 apart. When the high voltage
20 power supply is detached from the cartridge and probe 13 is pulled out of opening 16 (Fig. 4A), spring element 17 connects inside screen 4 to frame 1 (ground) and discharges the charge on screen 4 via wire 19.

An alternate version of the cartridge filter system comprises two outside screens, 20 and 21 (Fig. 5) supported by frame 22. Frame 22 is permanently attached to high voltage power supply box 8. The arrangement is such that there is space between screen 20 and 21 for a cartridge 23 (Fig. 6) which is similar to the one described before, but without outside screen 2 and 3. Instead of screens 2 and 3, cartridge 23 has two perforated retainer sides 24 and 25 made of metal, cardboard, plastic etc. The rest of cartridge 23 is made
30 exactly the same as the cartridge shown in Fig. 1, i.e. it has outside frame 1, inside screen 4, opening 16, spring 17, wire 19 and insulator 18.

Operation of the alternate arrangement is similar to the operation of the first arrangement. Cartridge 23 is placed between screens 20 and 21 and held in place by retainer clips 6 and 7. At the same time high voltage probe 13 (not shown in Fig. 5) passes through opening 16 and supplied high voltage to inside screen 4 via spring 17 and wire 19. Electrostatic field is set up between inside screen 4 and outside screen 20 and 21 which polarizes fibrous materials and thus attracts any dust particles which pass through the cartridge.

10 In filtering systems, sometimes many small filters are used in tandem to cover a larger area in a duct. Using the cartridge type approach, it is possible to drive several filter cartridges in tandem using only one high voltage power supply. Fig. 8 shows such an arrangement. Power supply 8 provides high voltage to inside screen 4 of cartridge a via probe 13, spring 17 and wire 19. Inside screen 4 is connected to the next filter b by high voltage probe 26. Probe 26 is similar to probe 13 in that it features a conductor inside an insulating sleeve. The sleeve is supported on outside frame 1 by a flange. Probe 26 supplies high voltage to screen 4 of cartridge b via spring 17, and wire 29 of cartridge b. Cartridge b is identical to cartridge a and is also provided with a probe 26, which can supply high
20 voltage to a third identical cartridge (not shown). Both cartridge a and b are provided with upper retainer clips 6 and lower retainer clips 7. By means of clips 6 and 7 these cartridges are attached to each other firmly so that probes 26 and 13 maintain good electrical contact with springs 7.

Filters of the charged media type are usually made thin (about 1 inch thick.) Because of this, the high voltage power supply has to be made long and slender so that, when attached to the cartridge, form a thin filter. To achieve this, the high voltage power supply electronics (see Fig. 9) is made of three parts A, B, and C. A is an electronic oscillator which drives transformer B. Transformer B provides about one tenth of the high voltage supply's output. Part C is a voltage multiplier which boosts the transformer's
30 output to the final high voltage. By using this design the voltage in the supply is gradually building up to the high voltage required to drive the filter without having any close parts at high potential difference. Therefore, this design can be built on a narrow and long printed circuit board which can be contained in a long and slender box.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. In an electronic air filtration system of the charged media type, a disposable air filter cartridge comprising:

- an electrically conductive frame adapted to solely and removably support an independent high voltage power supply unit which includes a box that houses a high voltage power supply, a high voltage probe that extends from said box and is adapted to pass through an opening provided in said frame, and means for attaching said high voltage power supply unit to said frame;
- first and second outside conductive screens attached to the opposing sides of said frame;
- an inside conductive screen disposed within said frame between said outside conductive screens;
- dielectric fibrous material disposed between said outside screens and said inside screen; and
- conductor means disposed within said frame for effecting electrical contact between said inside conductive screen and the high voltage probe of said independent high voltage power supply when said high voltage power supply is attached to said frame.

2. The disposable air filter cartridge as in claim 1 wherein said inside conductive screen is retained in its position by said dielectric fibrous material.

3. The disposable air filter cartridge as in claims 1 or 2 wherein said conductor means comprises a spring element attached to said inside conducting screen and positioned to contact the probe of said independent power supply unit when it is attached to said disposable air filter cartridge, said spring element being adapted to contact said outside conductive frame to automatically discharge said inside conductive screen when said independent power supply unit is removed from said disposable air filter cartridge.

4. In an electronic air filtration system of the charged media type, a disposable air filter cartridge comprising:

- an outside frame adapted to be solely and removably supported by an independent power supply unit which includes: a box for housing a high voltage power supply; first and second parallel spaced conductive frames attached to opposing longitudinal edges of said box, said first and second frames each supporting a conductive screen; a high voltage probe that extends from said box between said conductive screens and is adapted to pass through an opening provided in said frame;

first and second perforated retainer sides attached to said frame;
a conductive screen disposed within said frame between said perforated
retainer sides;

dielectric fibrous material disposed between said perforated retainer
sides and said conductive screen; and

conductor means disposed within said frame for effecting electrical
contact between said inside conductive screen and the high voltage probe of
said independent high voltage power supply when said high voltage power supply
is attached to said frame.

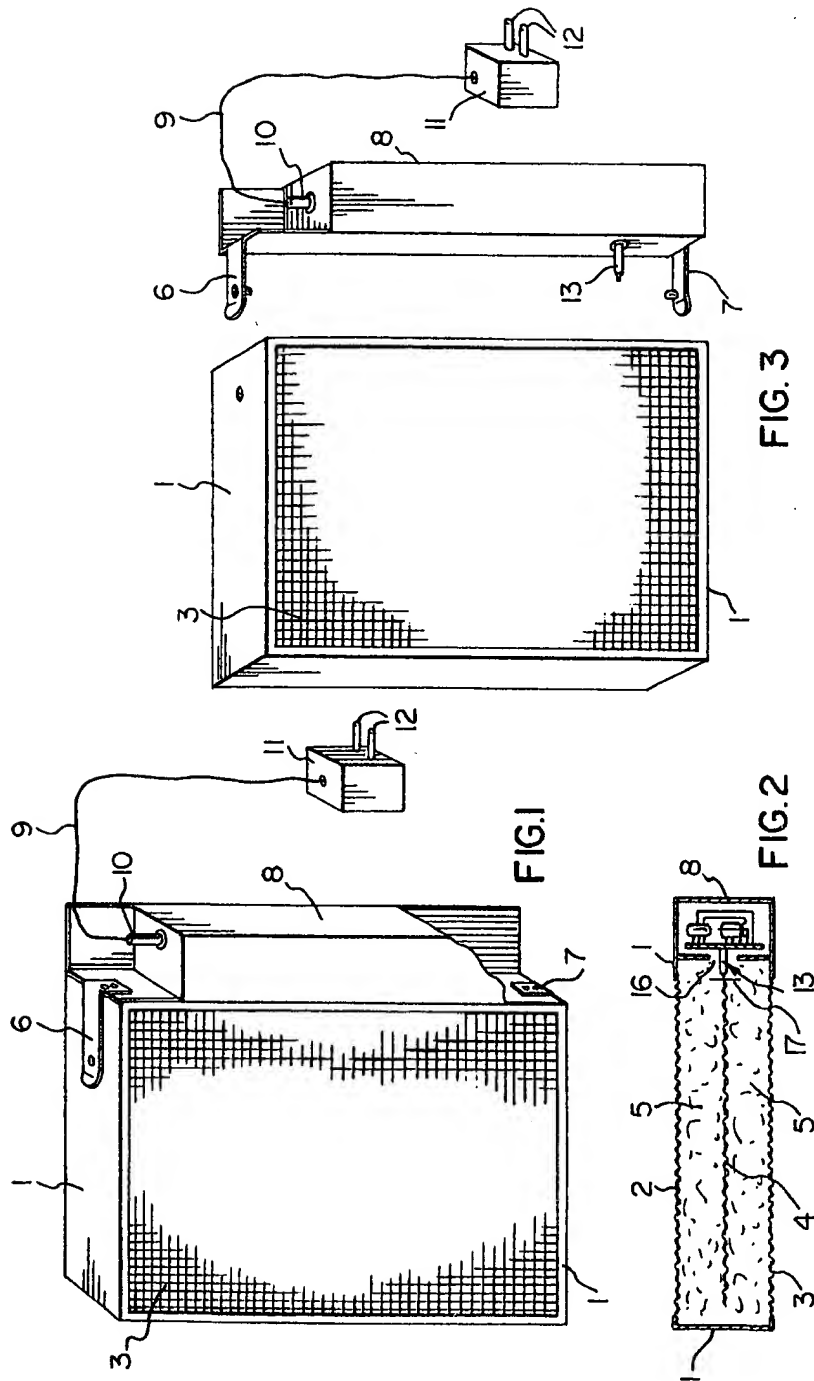
5. The disposable air filter cartridge as in claims 4 wherein said inside
conductive screen is retained in its position by said dielectric fibrous
material.

6. The disposable air filter cartridge as in claim 4 or 5 wherein said
conductor means comprises a spring element attached to said inside conducting
screen and positioned to contact the probe of said independent power supply
unit when it is attached to said disposable air filter cartridge, said spring
element being adapted to contact said outside conductive frame to
automatically discharge said inside conductive screen when said independent
power supply unit is removed from said disposable air filter cartridge.

7. A disposable air filter cartridge as in claim 1 further including
means for mechanically and electrically connecting a second disposable air
filter cartridge to its free edge so that a train of at least two filter
cartridges that are powered by a single high voltage power supply unit may be
assembled.

8. A disposable air filter cartridge as in claim 7 wherein said means for
mechanically connecting a second disposable air filter cartridge includes a
clip affixed to each end of the free edge of said cartridge, said clips being
adapted to engage holes in the ends of said second cartridge.

9. The disposable air filter cartridge as in claim 7 wherein said means
for electrically connecting a second disposable air filter cartridge comprises
a high voltage probe that extends from said edge and is adapted to pass
through an opening in the edge of the frame of said second disposable air
filter cartridge.



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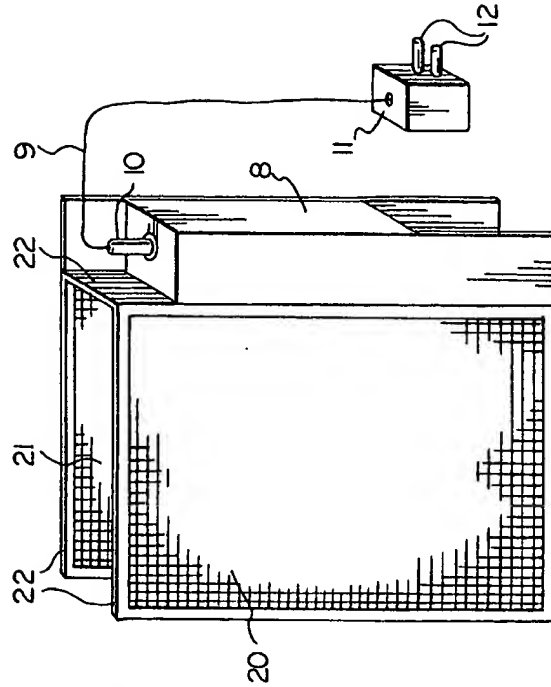


FIG. 5

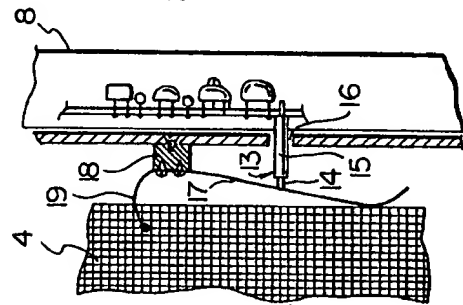


FIG. 4 b

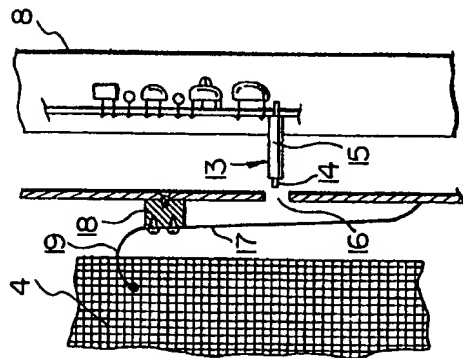


FIG. 4a

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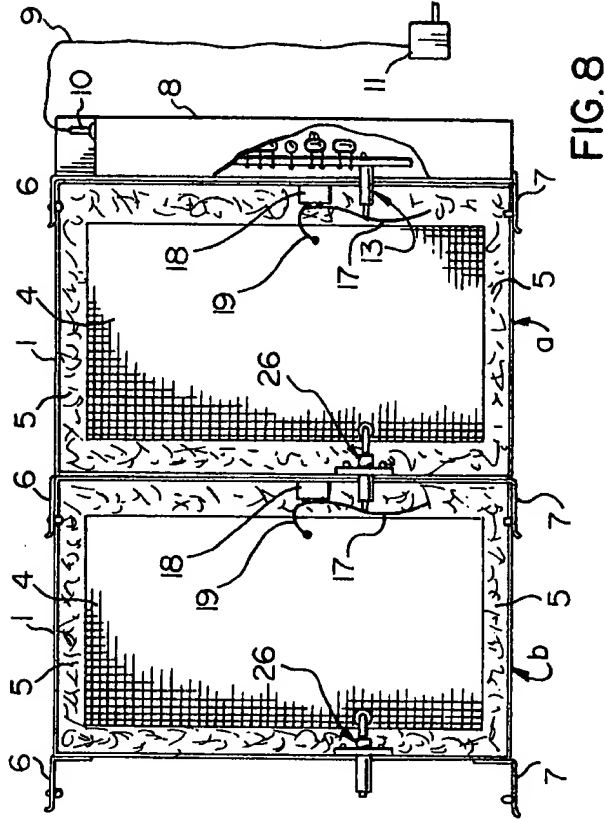


FIG. 8

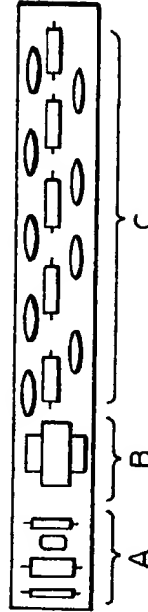


FIG. 9

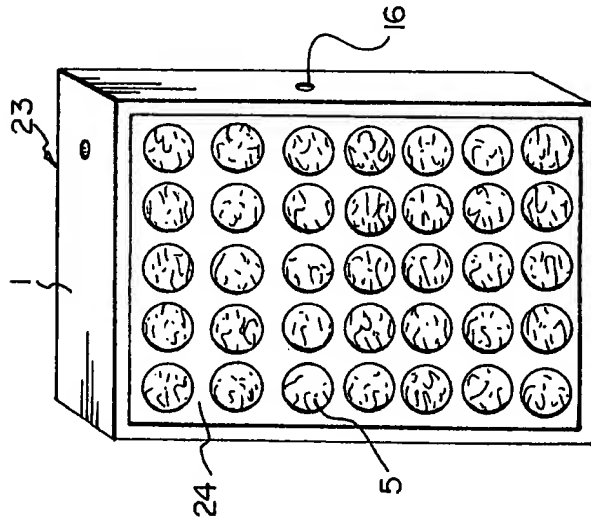


FIG. 6

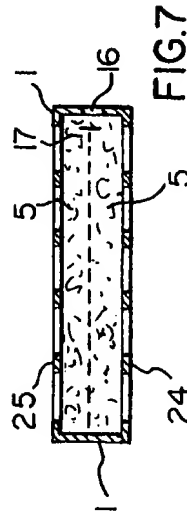


FIG. 7

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